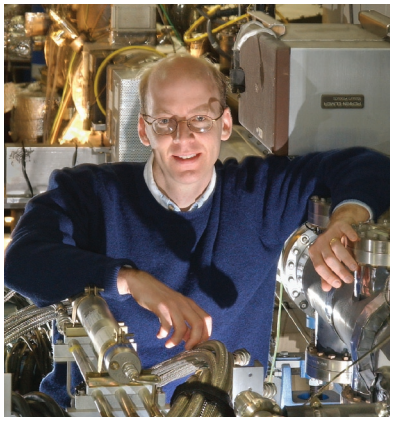
Researchers Discover Surface Orbital "Roughness" in Manganites

At the NSLS, researchers have shown that in a class of materials called manganites, the electronic behavior at the surface is considerably different from that found in the bulk. Their findings, which were published online in the November 18, 2007, issue of *Nature Materials* and could have implications for the next generation of electronic devices, which will involve increasingly smaller components.



John Hill

As devices shrink, the proportion of surface area grows in comparison to the material's volume. Therefore, it's important to understand the characteristics of a material's surface in order to predict how those materials behave and how electrons will travel across an interface, said Brookhaven physicist John Hill.

Hill and his fellow researchers were particularly interested in how the outer electrons of atoms in a so-called manganite material are arranged. Manganites – consisting of a rare-earth element such as lanthanum combined with manganese and oxygen – show a huge change in electrical resistance when a magnetic field is applied. Taking advantage of this "colossal magnetoresistance effect" could be the key to developing advanced magnetic memory devices, magnetic field sensors, or transistors.

The research team, which also includes scientists from KEK (Japan), CNRS (France), Ames Laboratory, and Argonne National Laboratory, used x-ray scattering at NSLS beamlines X22C and X21 and Argonne's Advanced Photon Source to study the orbital order — the arrangement of electrons in the outermost shell — of the material at the surface and in its bulk.

"When you cool down the bulk material to a particular temperature, all the orbitals arrange themselves in a very particular pattern," Hill said. "The question is, does the same thing happen at the surface? And if not, how is it different?"

The authors found that at the surface, the orbital order is more disordered than in the bulk material. And, even though the manganite's crystal surface is atomically smooth, the orbital surface is rough. These characteristics could affect the way electrons are transferred across a material's surface and provide fundamental information for future research and development. Next, the researchers plan to look for this surface orbital "roughness" in other materials and test its effect on magnetism.

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— Kendra Snyder